Silvicultural Note No. 17

The Marden Model 200 Spot Planter Trial

Ontario

Ministry of Natural Resources

Hon. Alan W. Pope
Minister

W. T. Foster
Deputy Minister

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PREFACE

Planting trials were conducted from July 19 to 30, 1982, in Ignace District, Ontario Ministry of Natural Resources, with the mechanical Marden Spot Planter, model 200. Results of the two-week test period indicate that the mechanical planter is unsuitable for use in Northern Ontario: planting quality was unacceptable, inter-tree spacing undesirable, and production rates below the manufacturer's claim. Further, low machine availability and the expense of the prime mover contributed to high planting costs.

The authors would like to thank Great Lakes Forest Products Limited for their assistance in rectifying several mechanical problems.

1.0 INTRODUCTION

The Marden Mechanical Spot Planter has been developed as an alternative to hand planting for areas in the southern United States. Sales representatives indicate that this machine is capable of planting 1200 trees per hour to an acceptable standard.

Fig. 1 Marden Spot Planter with D85A Komatsu and C.F.S. v-blade.

This report summarizes the results of a two-week operational trial carried out in Ignace District, in Northern Ontario, by the Ontario Ministry of Natural Resources. The test areas were sandy and relatively flat, and rock and slash conditions were minimal.

The report examines the planting quality and quantity of different stock types and discusses the design and operation of the planter. Suggested modifications to the planter are also presented.

2.0 EQUIPMENT

2.1 Marden Spot Planter, Model 200

The Marden Spot Planter (Fig. 1) is a single-row, intermittent-spot, bareroot and container tree planter. The machine is mounted on two high flotation tires and is towed behind a crawler-type tractor by means of a pin-hitch drawbar. It has its own self-contained power unit and hydraulic and electrical systems. All controls are located inside a partially enclosed, protected cab. The operator sits inside the cab, facing the rear of the machine.

The operator manually loads each seedling tree into the ejector guide fingers (Fig. 2) and then initiates the planting by depressing a foot-pedal switch. When the pedal switch is activated, the planter dibble travels downward (Fig. 3). As the dibble penetrates the soil, the packing wheel strikes the ground and activates the ejector solenoid, triggering the planting ejector cylinder (Fig. 4). After the seedling has been ejected and properly packed (Fig. 5), the operator releases the foot pedal, allowing the planter dibble to return to the reload position. The machine's planting technique, which involves a packing wheel, forms what the manufacturer calls a "catch water basin" beside each seedling.

The physical dimensions of this planter are provided in Appendix 1.

2.2 V-Blade

The Marden Spot Planter, like other mechanical planters, is not capable of acceptably planting seedlings without the use of a V-blade that serves as a slash divider. The blade must also continuously clear all debris and leave the soil intact for the subsequent planting operations. For these purposes, the C.F.S. V-blade was used during the operational trial.

Technical information regarding this V-blade is provided in Appendix 2.

Fig. 2
Loading seedling into guide fingers

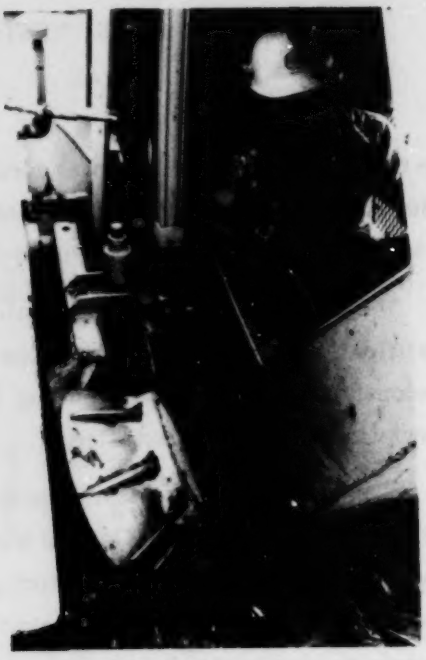


Fig. 3
Activating planter dibble via pedal switch

Fig. 4
Planting ejector cylinder activated by the packing wheel striking the ground

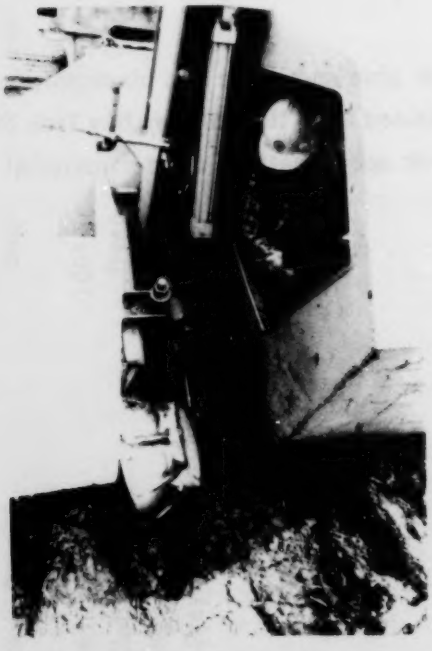


Fig. 5
Ejected seedling in process of being packed

3.0 TEST-SITE DESCRIPTION

The mechanical-planter trial was conducted on an area harvested during the spring of 1980. The area was predominantly jack pine sand flats. In addition, neighbouring areas of lowland black spruce were used in the trial.

The test site was stratified into several sections. The major criteria for this stratification were based on previous treatment, since a portion of the cutover had previously been site-prepared using barrels and chains. Table 1 gives the overall description of each site tested.

Slash loading for the test sites was carried out using the modified Van Wagner's method as described in the Ontario Ministry of Natural Resources' Prescribed Burning Manual. During this part of the study, the only site-breakdown categories used were "site-prepared" and "not site-prepared". Table 2 presents the overall slash loading and percentage breakdown by site. Minimal slash loading was present on the sites, as compared to typical slash-loading conditions on Northern Ontario cutovers.

4.0 PLANTING STOCK

Jack pine and white and black spruce bareroot stock of various ages and sizes were obtained from the Thunder Bay Tree Nursery for the trial. Table 3 outlines the nursery stock specifications of the material used.

TABLE 1
MARDEN SPOT PLANTER TEST-SITE DESCRIPTION

SITE DESCRIPTION	TEST SITE A	B	C	D	E
Previous Working Group					
- Jack Pine	27 ha	21 ha	nil	nil	1 ha
- Black Spruce	nil	nil	12 ha	1 ha	nil
Stumps/ha					
- 1-15 cm class	1040	1140	5540	5540	1140
- 15-16 cm class	140	155	755	755	155
Stoniness Class	nil	1 per $10m^2$	nil	1 per $10m^2$	1 per $4m^2$
Rock Outcrops	nil	1 per $100m^2$	nil	nil	1 per $100m^2$
Humus Depth	6-10 cm	6-10 cm	11-50 cm	11-50 cm	6-10 cm
Soil Type	sand	sand	organic over sand	organic over sand	sand
Soil Depth	100+ cm	51-100 cm	100+ cm	100+ cm	100+ cm
Soil Moisture	fresh	fresh	moist	moist	fresh
Slope	nil	5-15%	nil	nil	nil
Previous Treatment	barrels & chains	barrels & chains	barrels & chains	none	none

TABLE 2
SLASH LOADING BY SITE TYPE

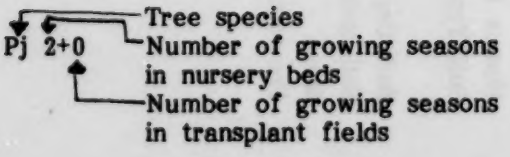
SITE CONDITIONS	SITE TYPE A,B,C	SITE TYPE D,E
Slash Loading (tonnes/ha)	47	25
Slash Depth (cm)	15	15
Slash Depth Range (cm)	0-60	0-20

Percentage Slash Weight by Diameter Class

DIAMETER CLASS	A,B,C (percent)	D,E (percent)
0.0-0.49 cm	4.0	3.5
0.5-0.99 cm	5.5	4.5
1.0-2.99 cm	24.4	15.0
3.0-6.99 cm	40.1	43.0
7.0+ cm	26.0	34.0
	100.0	100.0

TABLE 3
NURSERY STOCK SPECIFICATIONS (THUNDER BAY NURSERY)

STOCK	SITE REGION	S/R	RAI	RCD	ODW
Pj 2+0	47-3200	4.1	25	3.5	1.8
	21-4400	4.7	25	3.6	3.0
	25-4400	4.7	25	3.4	3.0
Sb 1+2	3400	1.8	55	4.5	5.4
Sw 1+2	3400	2.4	45	5.4	7.7
Sw 2+2	3400	2.3	46	5.9	12.7



S/R shoot/root ratio
RAI root area index
RCD root collar diameter (mm)
ODW oven dry weight (g)

5.0 OPERATION-TRIAL RESULTS

5.1 Planting Production

The highest planting production during the operation trial was achieved using Pj 2+0 on Site A, where 880 trees per productive machine hour were planted. Table 4 shows the planter's production by site and stock type.

The mechanical planter achieves, at best, 75 percent of the manufacturer's planting production claim.

5.2 Planting Quality

The planting quality of the Marden Spot Planter is unsatisfactory. Table 5 summarizes the planting quality achieved by site and stock type. A more detailed summary of planting quality by test site, stock type, and size is provided in Appendix 3.

The quality criteria for an acceptable planted tree are based on the guidelines set out in the Northwest Region's Planting Quality Report. That is, a tree is acceptable if it is less than 30 degrees off the vertical, planted to the depth of the root collar, and packed firm.

A general discussion of planting quality by stock type is presented below.

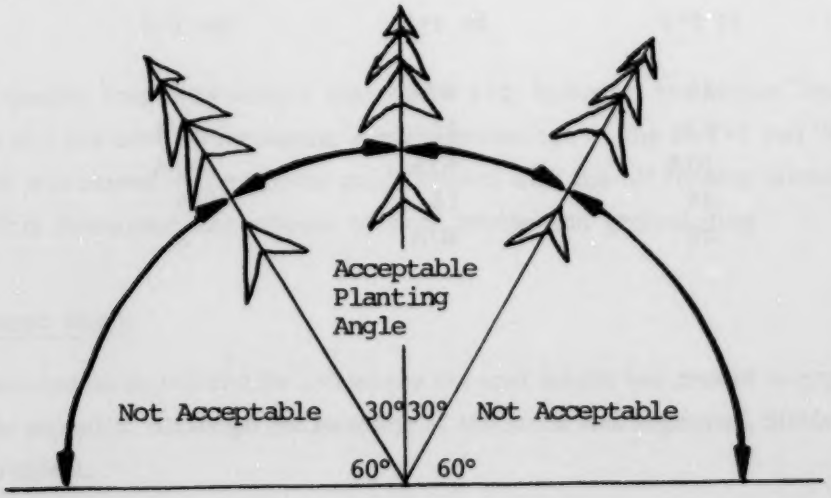


Fig. 6 Acceptable Planting Angle

TABLE 4
PRODUCTION BY SITE AND STOCK TYPE

SITE	NUMBER OF TREES PER PRODUCTIVE MACHINE HOUR			
	Pj 2+0	Sb 1+2	Sw 1+2	Sw 2+2
A	880	N/A	670	600
B	800	750	N/A	N/A
C	N/A	800	N/A	750
D	860	675	N/A	N/A
E	N/A	N/A	N/A	N/A

N/A — Figure not available for various reasons.

TABLE 5
PLANTING QUALITY BY SITE AND STOCK TYPE

SITE	PERCENTAGE OF TREES ACCEPTABLY PLANTED BY STOCK TYPE			
	Pj 2+0	Sb 1+2	Sw 1+2	Sw 2+2
A	48	N/A	25	25
B	17	25	N/A	N/A
C	N/A	N/A	N/A	10
D	25	16	35	N/A
E	20	N/A	0	N/A

Pj 2+0

The best overall Pj 2+0 results were obtained with the large and medium stock (Table 6). The lower-quality planting resulting from smaller stock was a function of the high position of the ejector guide fingers within the dibble and, to a lesser extent, with all stock sizes, the excessive depth of the plough furrow.

The planter rarely plants trees too deep but results showed a high percentage of seedlings planted too shallow. This was consistent for the different species and stock sizes tested.

Sw 1+2

The smallest-size Sw 1+2 gave the best results of the three sizes tested; results with the large stock were the least desirable. The bulky and fibrous roots of transplant spruce created resistance in the dibble during ejection (dibble drag). The shoot section of the seedling, when ejected, met less resistance in the ejector guide fingers than the roots met in the dibble. This caused many seedlings to be planted in a slanted or horizontal position or to be left unplanted.

Sw 2+2

The lowest overall planting quality was exhibited by all sizes of Sw 2+2 tested. In addition to dibble drag, the length of the roots exceeded the dibble capacity, causing the roots to drag along the ground prior to and during ejection (ground drag).

Sb 1+2

Planting quality roughly averages that of Sw 1+2; however, the larger black spruce seedlings had the best performance. A high percentage of the Sb 1+2 was "J" rooted. This stock was placed in the ejector guide fingers with the "J" running inward into the dibble. This decreased the effects of both dibble and ground drag.

Root-Pruned Stock

Trials were run on Sb 1+2 and Sw 2+2 where the root length was pruned to approximate the dibble capacity. Although the handling of the stock was improved, dibble drag was still a problem.

Further discussion of factors associated with planting quality is presented in section 6.0, "Design and Operation Problems".

TABLE 6
QUALITY ASSESSMENT

SPECIES	SPECIES SIZE	ANGLE			FIRMNESS			PLANTING DEPTH			ACCEPTABLE PLANT	SAMPLE SIZE
		VERT.	SLANT (percent)	HORIZ.	FIRM	LOOSE (percent)	UNPLANTED	TOO DEEP	GOOD (percent)	TOO SHALLOW	(percent)	(trees)
Pj 2+0	Large	39	38	11	66	22	12	3	53	32	26	111
	Medium	38	31	11	57	23	20	3	53	24	30	414
	Small	32	18	18	45	23	32	5	35	28	20	108
Sb 1+2	Large	36	44	15	70	23	5	0	62	33	33	39
	Medium	22	27	28	39	38	23	0	30	47	12	88
	Small	29	18	29	44	30	24	2	36	38	20	45
Sw 1+2	Large	22	17	17	34	22	44	11	17	28	17	18
	Medium	35	40	7	58	24	18	8	42	32	20	84
	Small	54	17	4	50	25	25	0	58	17	29	24
Sw 2+2	Large	22	33	22	44	22	33	0	44	22	11	9
	Medium	21	48	10	55	24	21	2	44	33	21	42
	Small	20	30	40	50	40	10	0	40	50	0	10

Unplanted + Vertical + Slanted + Horizontal = 100%
Firm + Loose + Unplanted = 100%
Unplanted + Too Deep + Good + Too Shallow = 100%

Acceptable: planted tree that is vertical, form, and planted to a correct depth.

5.3 Tree Spacing

The ideal tree spacing of 2 metres x 2 metres could not be obtained using the Marden Spot Planter in conjunction with the C.F.S. V-blade. Table 7 presents the average row and tree spacing by stock type. The large row spacing is governed by slash encroachment from adjacent passes of the V-blade. Inter-tree spacing is large, a result of the slow cycle time of the dibble and packer. In addition, the larger transplant stock was harder to handle and place into the ejector guide fingers, thereby further slowing the cycle time.

TABLE 7

AVERAGE SPACING AND STOCKING BY STOCK TYPE

STOCK	ROW SPACING	TREE SPACING	TREES/HECTARE
Pj 2+0	2.7 m	2.7 m	1371
Sb 1+2	2.9 m	3.4 m	1014
Sw 1+2	2.5 m	3.2 m	1250
Sw 2+2	2.6 m	4.0 m	961

5.4 Tree Stocking

Analysis of the test sites indicated that the optimum stocking of 2500 trees per hectare could be achieved using the standard site-preparation and hand-planting technique. As indicated in Table 7, the Marden Planter and V-blade combination did not achieve the optimum. The restrictions to achieving the optimum stocking are the same as those outlined under section 5.3, "Tree Spacing".

5.5 Machine Availability, Operating Cost Per Productive Machine Hour, and Cost Per Thousand Seedlings Ejected

5.5.1 Machine availability

The machine availability was calculated using the following formula:

$$\text{Machine Availability} = \frac{\text{B) Productive Machine Hours}}{\text{A) Available Machine Hours}} \times 100$$

where A) The available machine hours (AMH) were the total hours the prime mover was scheduled to work, excluding legal breaks, such as lunch and coffee time, as set out in the tender agreement. The total AMH for this trial was 110.75 hours.

and B) The productive machine hours (PMH) were the AMH minus both lost utilization time and paid standby time. Lost utilization time (i.e., walking the machine between test sites) totalled 6.65 hours. Standby time was the time lost due to repairs or adjustment to the planter, the V-blade, and prime mover and accounted for 41.25, 5.25, and 0.00 hours, respectively.

PMH = 110.75 - (6.65 + 41.25 + 5.25 + 0.00) = 57.60

$$\text{Machine Availability} = \frac{\text{B) } 57.60}{\text{A) } 110.75} \times 100 = 52\%$$

5.5.2 Operating cost per productive machine hour

The operating cost per PMH was calculated as the sum of: the cost of transporting equipment to and from the site, total prime mover rental, planter fuel, planter grease, and field maintenance, divided by the PMH. Added to these costs were the hourly wages of both the planter operator and the field supervisor, who was in charge of tree procurement and quality control, divided by the machine availability.

a) Transportation Cost/PMH (Ignace to test site and return for planter, prime mover and V-blade at regional tender rate)
$= \frac{150 \text{ km}}{57.60} \times (\$2.64/\text{km}) = \$ 6.87$

b) Total Prime Mover Cost/PMH
$= \frac{\$7187.50}{57.60} = \$124.78$

c) Planter Fuel Cost/PMH
$= \frac{100\,\ell}{57.60} \times (\$0.35/\ell) = \$ 0.60$

d) Planter Grease Cost/PMH
$= \frac{\$1.25}{57.60} = \$ 0.02$

e) Field Maintenance Cost/PMH
$= \frac{\$206.00}{57.60} = \$ 3.58$

f) Planter Operator Cost/PMH
$= \$10.40/\text{hr} \times \frac{(100\%)}{(52\%)} = \$ 20.00$

g) Field Supervisor Cost/PMH
$= \$10.80/\text{hr} \times \frac{(100\%)}{(52\%)} = \$ 20.77$

h) Total Operating Cost/PMH (sum of (a) to (g)) $176.62

The total operating cost of $176.62 per PMH does not include the cost of employee fringe benefits or depreciation, preventive maintenance, and interest on average annual investment for the equipment. The total operating cost per PMH should resemble that which would result when using the planter on an operational basis. (Appendix 4 summarizes the total cost of all expenditures involved with the planter trial, including site and data analysis, equipment freight, et cetera.)

5.5.3 Cost per thousand seedlings ejected

The cost per 1000 seedlings ejected, disregarding the planting quality, was calculated as follows:

Cost/1000 = Operating Cost/PMH x (1000 / Number of Trees per PMH)

An example of the cost per 1000 seedlings ejected, using the highest production rate of 880 Pj 2+0 trees/PMH on Site A, is as follows:

Cost/1000 = ($176.62) x (1000 / 880) = $200.70

The cost per 1000 seedlings ejected, using the lowest production rate of 600 Sw 2+2 trees/PMH on Site A, is as follows:

Cost/1000 = ($176.62) x (1000 / 600) = $294.37

The cost per 1000 seedlings ejected of $200.70 for Pj 2+0 and $294.37 for Sw 2+2 were not true costs since the percentage of acceptable planted trees per site was only 48% and 25%, respectively, on Site A.

6.0 DESIGN AND OPERATION PROBLEMS

Discussed in this section are on-site problems encountered with the design and operational performance of the planting equipment.

6.1 Marden Spot Planter

The Marden Spot Planter's operation sequence is relatively uncomplicated. Through experimentation, the operators learn to make the adjustments required to achieve optimum performance.

6.1.1 Planting Depth

Control of the planting depth is difficult to maintain at a constant level since the depth of dibble penetration into the soil is predetermined by hydraulic pressure.

6.1.2 Planting quality

Stumps, slash, and rocks interfere with the completion of the planting cycle and have two major effects on the planting quality and spacing. The first is that if dibble penetration is inhibited, premature seedling ejection may result. Secondly, stumps, slash, and rocks may inhibit the packing wheel from firming up the tree.

6.1.3 Packing wheel function

The packing wheel (part #42) functions on the principle of ramming and angling the soil firmly against the planted tree. Roots show no evidence of "J" rooting and air pockets are nonexistent. The distortion encountered is that the roots are packed on one plane.

The trenches developed by the packing wheel are somewhat V-shaped but with a more gradual slope towards the seeding. During a drought period, the trees suffering from moisture stress will additionally be subjected to an increased moisture loss from the trench face.

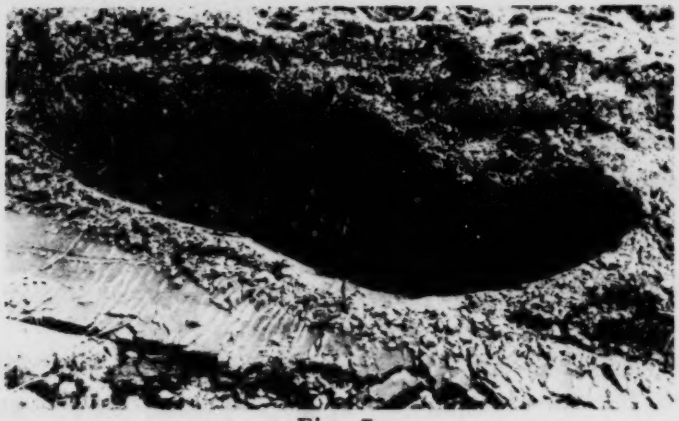


Fig. 7
Jack pine seedling seen planted in sandy medium.
Note packing trench in background.

6.1.4 Ejector guide fingers

Placement of trees in the ejector guide fingers was awkward. This resulted in poorer planting quality and increased lineal spacing. Trees could not be placed in the ejector guide fingers at the root-collar level. In most cases the seedling had to be positioned approximately half-way up the chute in order to achieve satisfactory planting depth. The ejector guide fingers were simply positioned too high in the dibble.

6.1.5 Engineering

Bending and twisting of the packing-wheel arm where it attaches to the packing wheel (part #42a) occurred as a result of impact with rocks and stumps. To continue the trial, the packing-wheel arm was realigned and reinforced with additional gussets.

Further, there were numerous occurrences of nuts and bolts loosening at various locations. The crank axle mounting bolts (part #33) were the most critical. This is the primary attachment of planter cab and planting assembly to the section housing the Diesel engine. It was also noted that the crank axle mounting plate bent at the location of the sub plates (part #35). In addition, the threaded attachment bolts fell out of the planting ejector cylinder (part #207). The wheel beside the operator also loosened and the tire wheel studs needed periodic tightening during daily equipment checks.

Constant attention had to be given to the turn buckle (part #14) due to loosening of the nut. Towards the end of the planting trial, minor hydraulic-fluid leakage started to occur at the connection to the dibble activator cylinder and at the hydraulic filter connection.

Throughout the trial period problems were encountered with the Murphy Diesel engine. The fuel injector began malfunctioning the first day and had to be replaced. Mid-way through the trial period the alternator shaft locking bolt loosened. This necessitated the replacement of the alternator. In addition, nuts had to be tightened on various locations of the engine. Engine problems encountered were covered by warranty.

Other problems encountered were loosening of the blower shaft on the engine, bending of tire valve stems since they were exposed, breaking of the throttle handle and seat adjuster, and the beginning of a small weld separation on the body beside and behind the operator.

6.1.6 Prime mover and hookup

The 85A Komatsu tractor, mounted with the C.F.S. V-blade, had no problem pulling the 2.7 tonne planter, with the exception of Site B, where rocky slopes resulted in tractor pad slippage. It is felt that the equivalent of a D7 caterpillar could do the same job. The drawbar set-up could be improved since the planter trails too close behind the tractor, resulting in pinching of the front corners of the planter on tight turns. This led to a weld separation of an angle-iron reinforcing bar that runs along the front corners.

Proposed changes to the Marden Spot Planter as a result of this field trial are discussed in section 7.0, "Suggested Modifications".

6.1.7 Operator comfort

The planter is well designed for operator comfort. However, in periods of long duration, the operator should wear a kidney belt. After an eight-and-a-half-hour trial with one operator wearing a kidney belt, no marked decrease in planting quality or quantity was observed. The operator did complain, at times, about exhaust emitted from the Diesel engine. Engine exhausts are emitted towards the ground and then circulate upward into the cab. The operator must wear ear plugs during operation for protection against noise created by the Diesel engine and action of the planting mechanism.

6.1.8 Safety

The planter is not safe to operate without proper site-preparation with a V-blade. This conclusion was drawn from an incident where a 10-cm-diameter log ran upward in front of the packing wheel, nearly pinning the operator's arm against the plow cylinder (part #213).

Fig. 8

Simulation of the near accident in unscarified cutover. The log was forced against the operator's arm momentarily before the log jammed and snapped against the plow cylinder.

There were also occurrences of sticks pushing up through the drainage holes near the operator's feet. On occasion, heavy slash would get jammed between the packing-wheel arm and the exterior seedling-storage bin.

One of the good safety features of the planter is the hydraulic kill switch, located in the cab, which enables safe entry and exit while the motor is running.

6.2 C.F.S. V-Blade

The C.F.S. V-blade's path was not wide enough to offset frequent occurrences of slash, stump, and root interference with the packing wheel. Even though the seedlings were planted in the middle of the bladed area, the packing wheel packed soil on the outer edge of the bladed swath, resulting in many loose and angle-planted seedlings. However, a wider plow would possibly create a greater inter-row spacing. The key to

successful plants was the exposure of mineral soil. Slash and duff must be removed to achieve a satisfactory and consistent plant. The C.F.S. V-blade, when properly adjusted, achieved a marginal exposed path.

The rolling drum at the bottom enabled the V-blade to "float", thereby eliminating constant manipulation of the dozer blade. However, the V-blade could not be relied upon to continuously operate on float; manual direction was needed periodically.

Overall, planting quality could be improved by mounting a blade specifically designed for the Marden Spot Planter.

7.0 SUGGESTED MODIFICATIONS

As a result of this two-week trial of the Marden Spot Planter, the following list of suggested modifications is presented. These suggestions are categorized under the following headings: Safety, Design, and Performance.

7.1 Safety

a) For operator safety, a protector plate should be installed between the cab and hydraulic hoses in the event of puncture or blowout.

b) A safety kill switch, convenient for shutting off the engine in the eventuality that the throttle jams, should be installed.

c) The dozer operator signal horn should be remounted inside the dozer cab to enable a more spontaneous response.

7.2 Design

a) The seedling storage bin is located beside the hydraulic-fluid storage tank, resulting in excessive heating of planting stock. Insulation should be set in between.

b) A larger-capacity dibble, necessary for transplant spruce stock, should be provided.

c) The tractor hookup assembly should be elongated to prevent pinching of the planter when turning.

d) More bolts are necessary on the crank axle mounting plate, particularly near the location of the sub plates (part #35) since this is where the greatest stress occurs.

e) Additional gusset reinforcements should be welded on the packing-wheel arm. The majority of bending occurred at the location where previous gussets ended.

f) The engine exhaust should be redirected to be emitted over top of the planter and a protector plate, covering the exhaust system, should be installed.

g) A second lock nut should be installed on the turn buckle (part #14) to prevent the original nut from loosening.

h) Tire valve stem protectors should be installed to prevent damage from slash.

7.3 Performance

a) The planter should be redesigned so that the packing wheel:

   i) is in continuous contact with the ground, thereby reducing the cycle time. A spring-loaded torsion bar set-up would prevent damage upon hitting rocks or stumps. With this design the need for hydraulic power to the packing wheel would be eliminated.

   ii) has the ability to be adjusted to different angles to achieve satisfactory packing under various soil conditions.

   iii) is centred more to the middle of the bladed swath so that interference from slash, stumps, roots, and duff can be reduced.

b) The planting cycle should be automated at a 2-metre lineal spacing with an accumulator to allow the dibble to slide over interfering obstacles to complete the planting cycle rather than aborting the tree.

c) To achieve a constant depth of plant, a soil surface sensor should be installed on the dibble, or the plow cylinder, to regulate the depth of penetration, rather than relying on the hydraulic pressure setting.

d) The ejector guide fingers should be redesigned so that:

   i) their positioning is adjustable on the ejector plate (part #45). This would allow the placement of the seedling in the fingers at the root-collar level, thereby reducing the number of too-deep or too-shallow plants.

   ii) The fingers should be flared at the end to facilitate easier placement of the seedling by the operator.

8.0 SUMMARY

The model 200 Marden Spot Planter had an unsatisfactory performance in this trial study. Planting quality was inconsistent and the number of acceptably planted trees was low. The inter-tree spacing was not desirable with the mechanical planter. Production rates were, at best, 75 percent of the manufacturer's claim. These factors, combined with the expense of the prime mover and low machine availability, create an excessively high planting cost. In addition, the planter was considered unsafe to the operator. Redesign of various components associated with structural strength and planting action are recommended to upgrade the machine.

9.0 CONCLUSIONS

The Marden Spot Planter is not recommended for use on Northern Ontario cutovers. Its practical application may be more suited to Southern Ontario, possibly for use in afforestation of abandoned farmlands. Design of the planting mechanism is a major deterrent in achieving acceptable planting standards. Other modifications to design are necessary to improve operator safety, machine availability, and operational performance.

10.0 LITERATURE CITED

Ontario Ministry of Natural Resources. 1982. Planting Quality Sub-Committee report. Ontario Ministry of Natural Resources, Northwestern Region.

—. 1981. Prescribed burning manual. Aviation and Fire Management Centre, Ontario Ministry of Natural Resources.

APPENDIX 1

MARDEN SPOT PLANTER: TECHNICAL INFORMATION

Marden Spot Planter

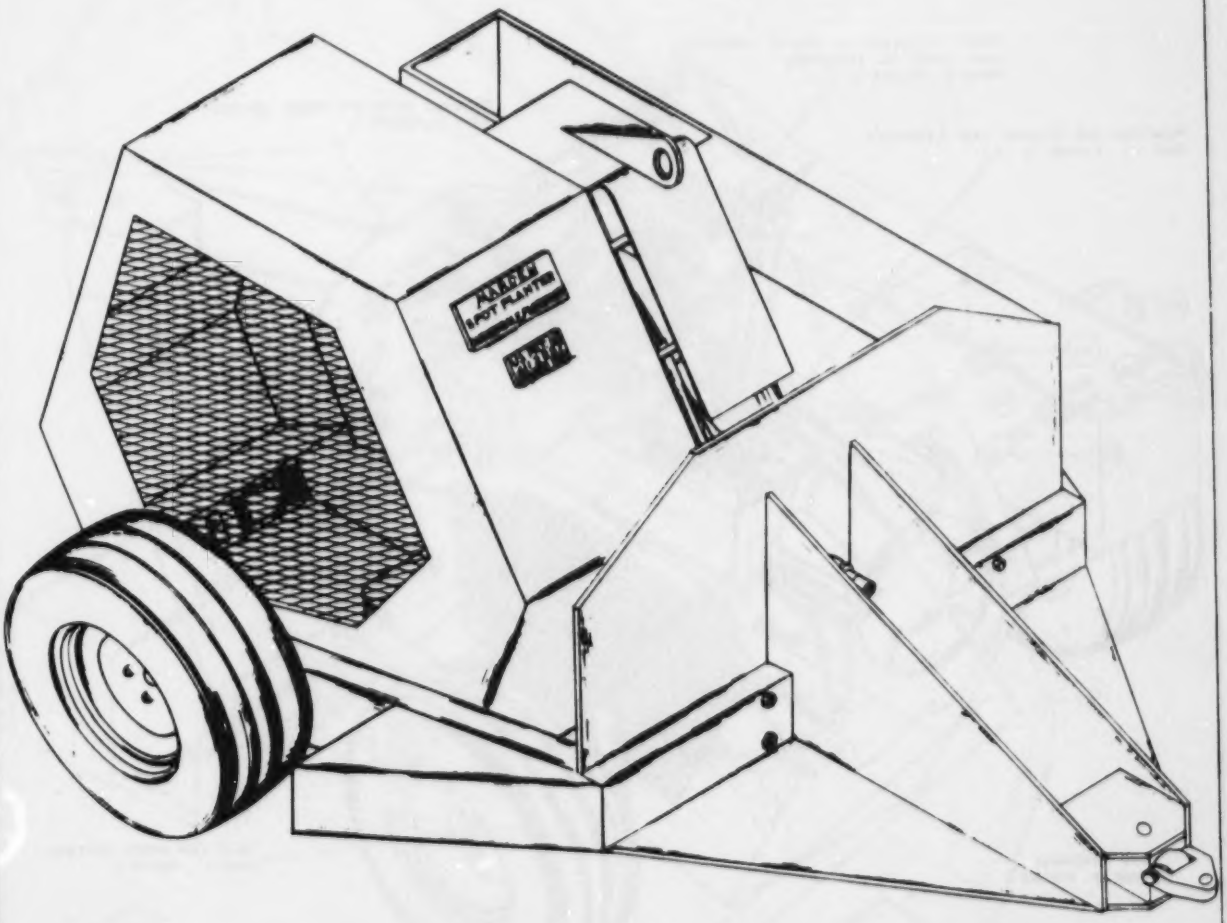


FIGURE 1
Marden SPOT PLANTER DIAGRAM
MODEL 100

Marden Spot Planter

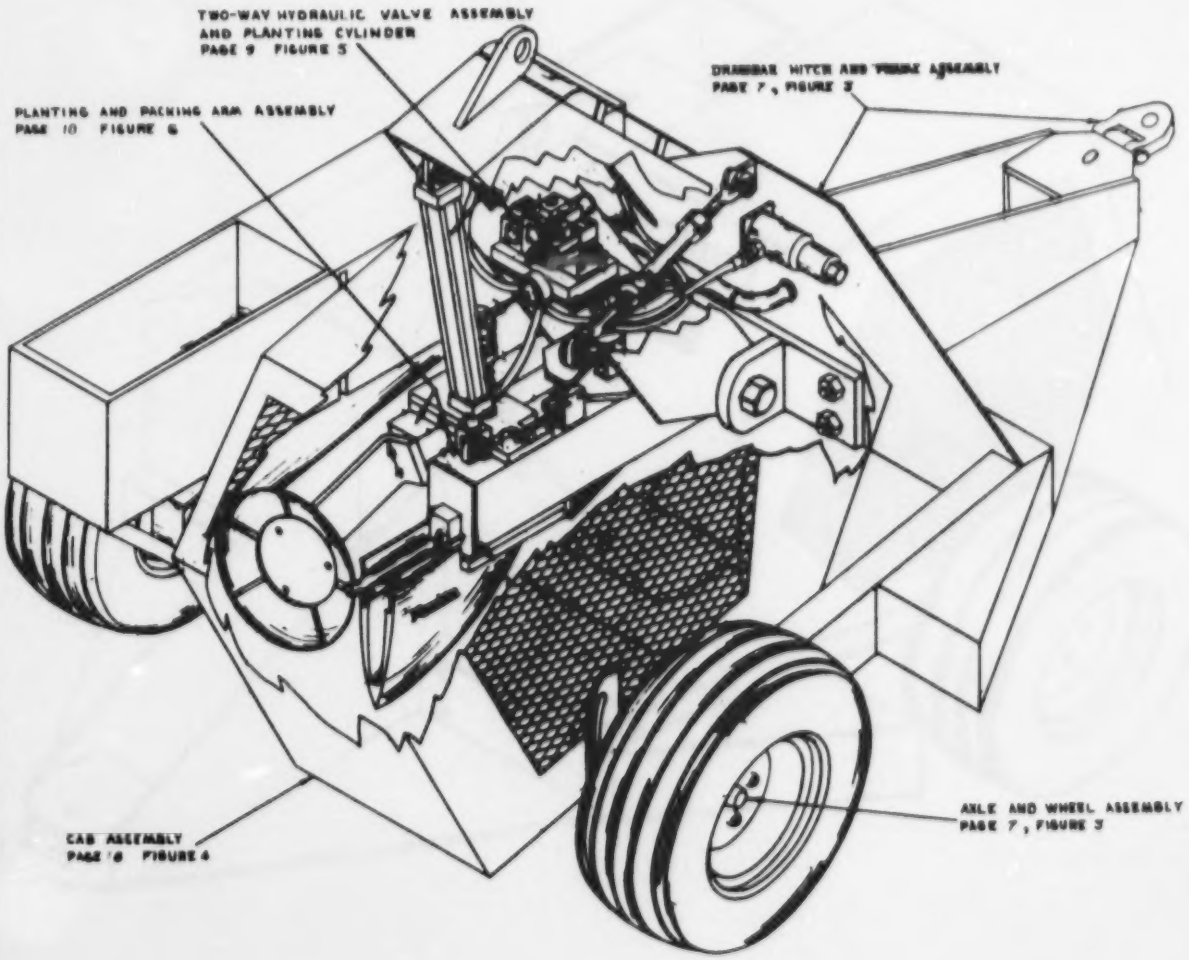


FIGURE 2

MARDEN SPOT PLANTER ASSEMBLY DIAGRAM
MODEL 100

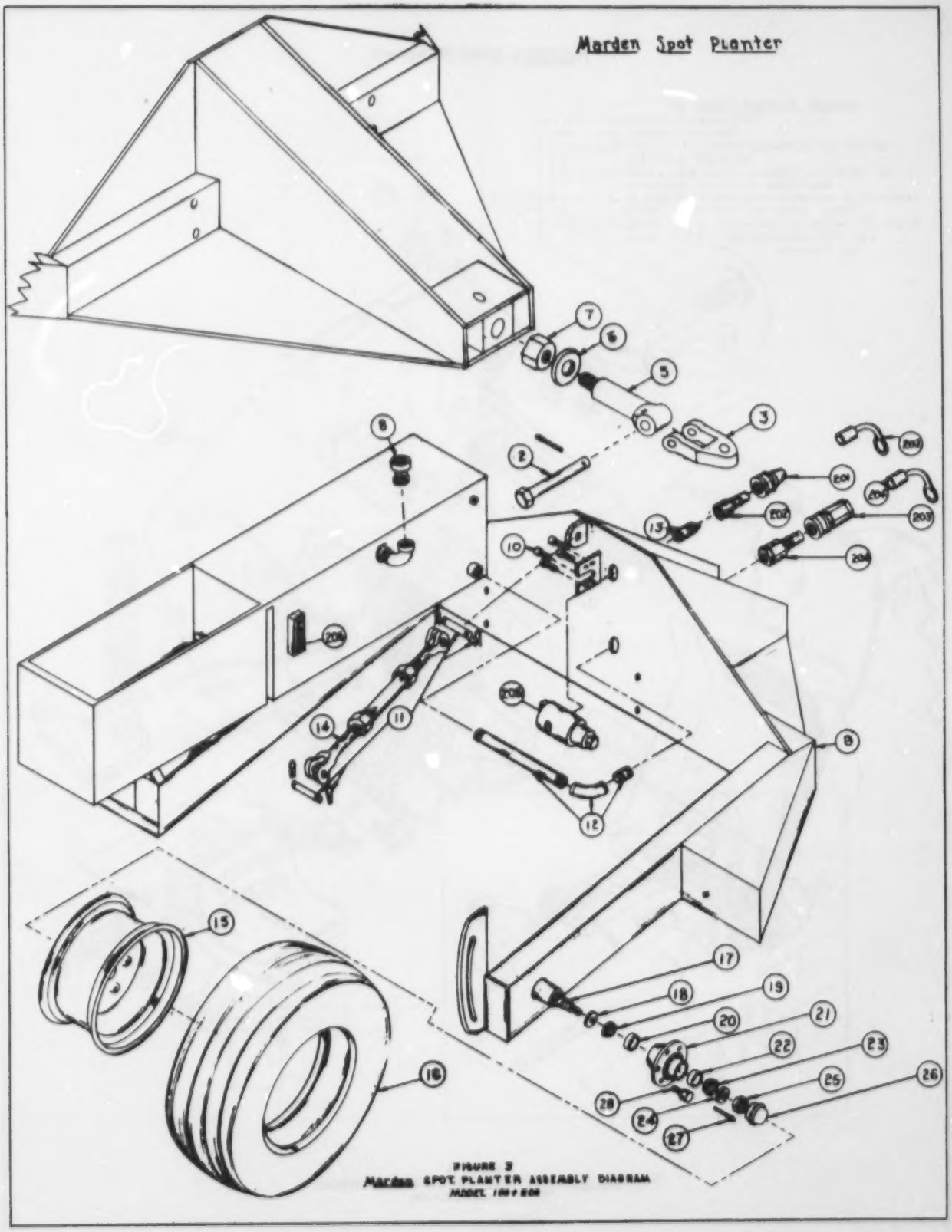


FIGURE 3
MARDEN SPOT PLANTER ASSEMBLY DIAGRAM
MODEL 100 & 600

Marden Spot Planter

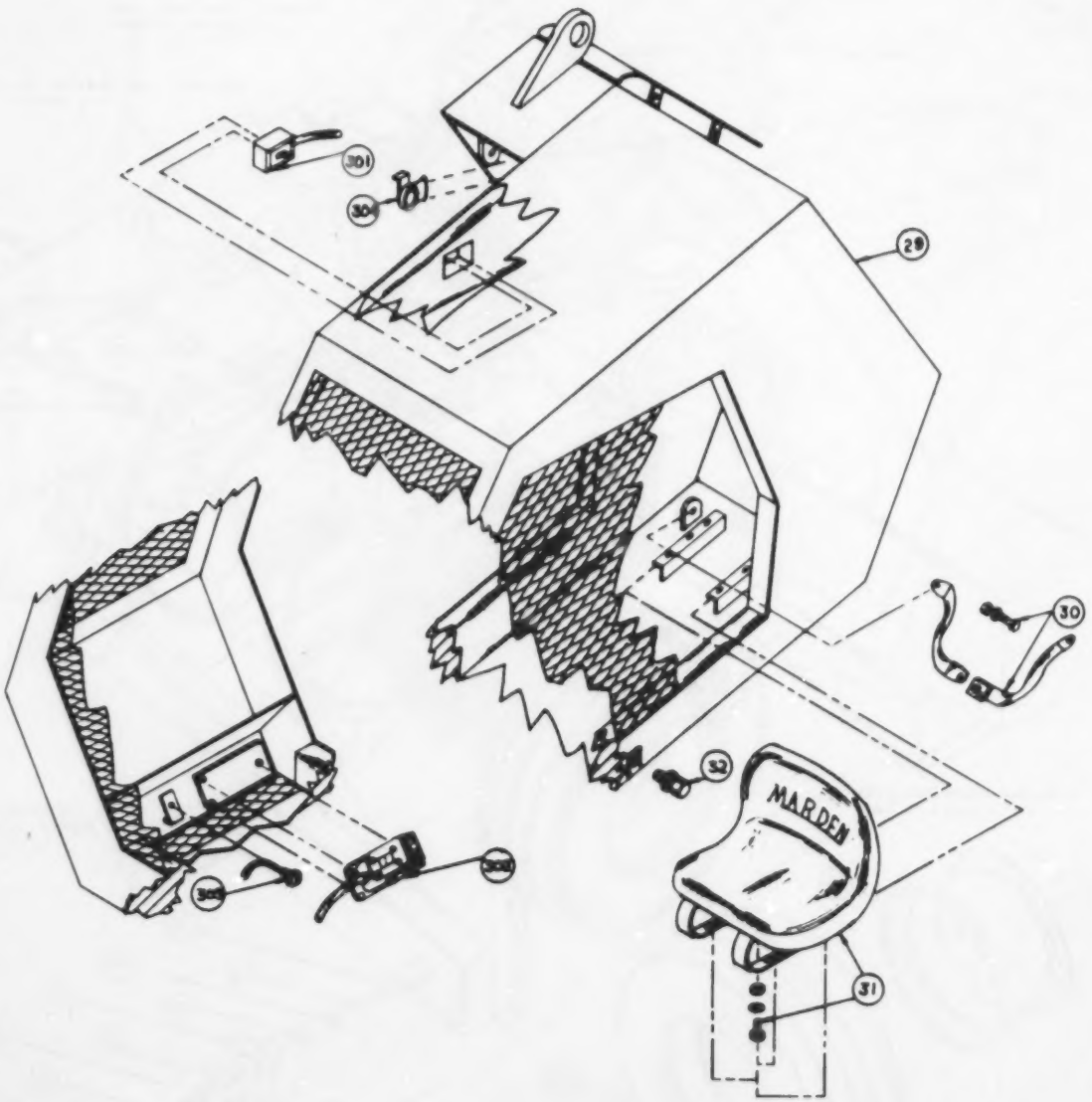


FIGURE 4
Marden SPOT PLANTER ASSEMBLY DIAGRAM
MODEL 100 + 200

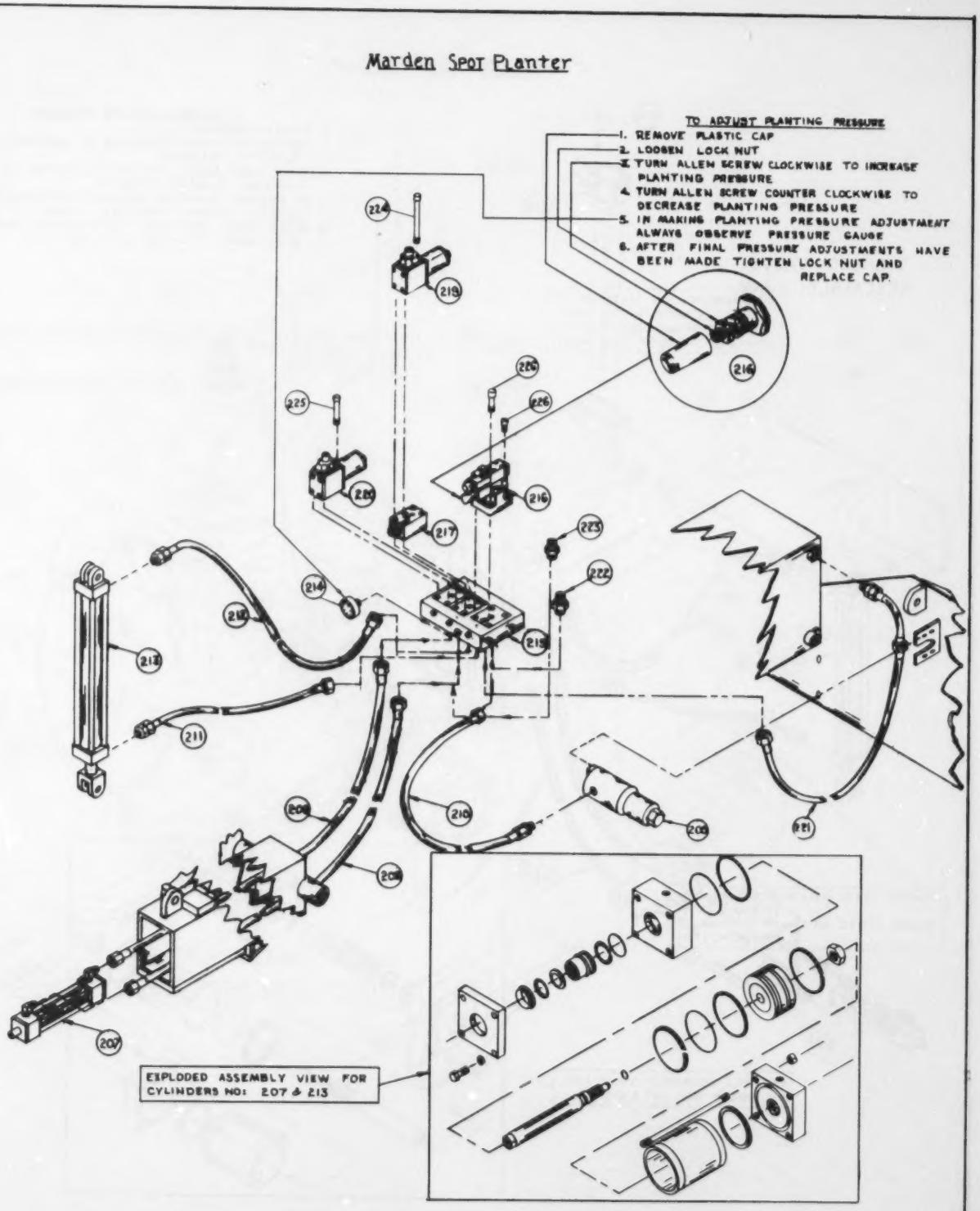


FIGURE 5
MARDEN SPOT PLANTER HYDRAULICS DIAGRAM
MODEL 100 + 200

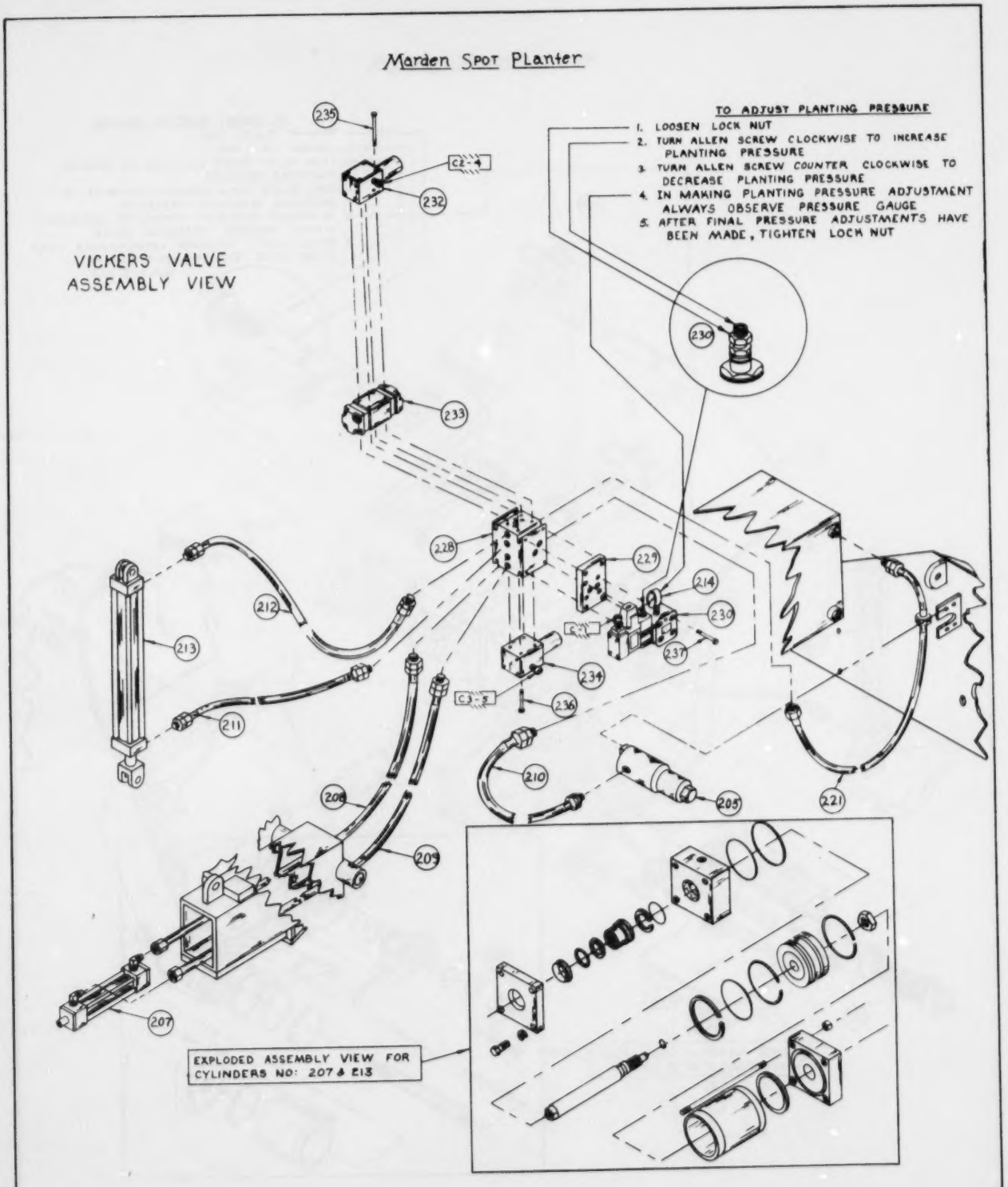


FIGURE 5-A
Marden SPOT PLANTER HYDRAULICS DIAGRAM
MODEL 100+200

Marden Spot Planter

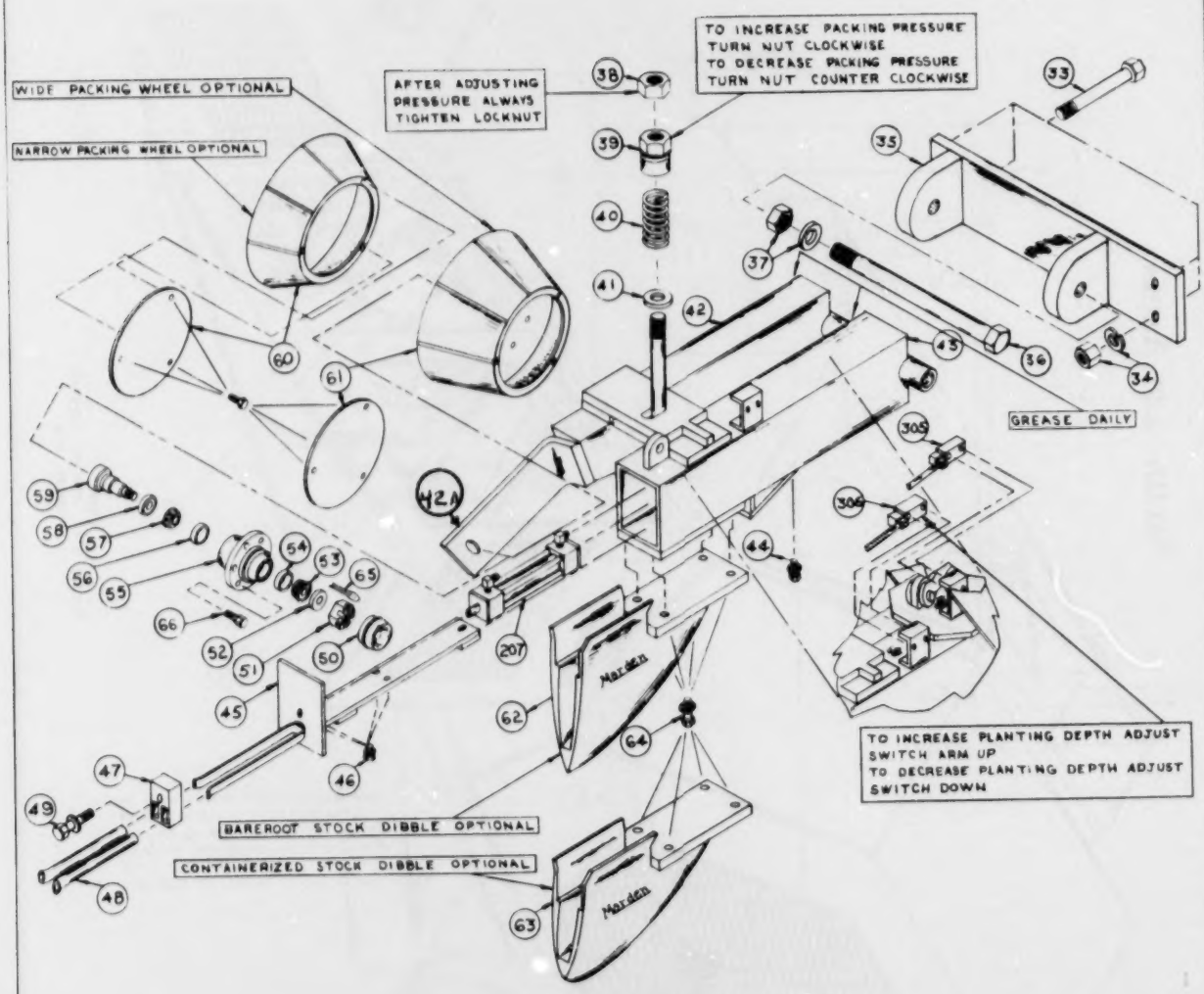


FIGURE 6
Marden SPOT PLANTER ASSEMBLY DIAGRAM
MODEL 100 + 200

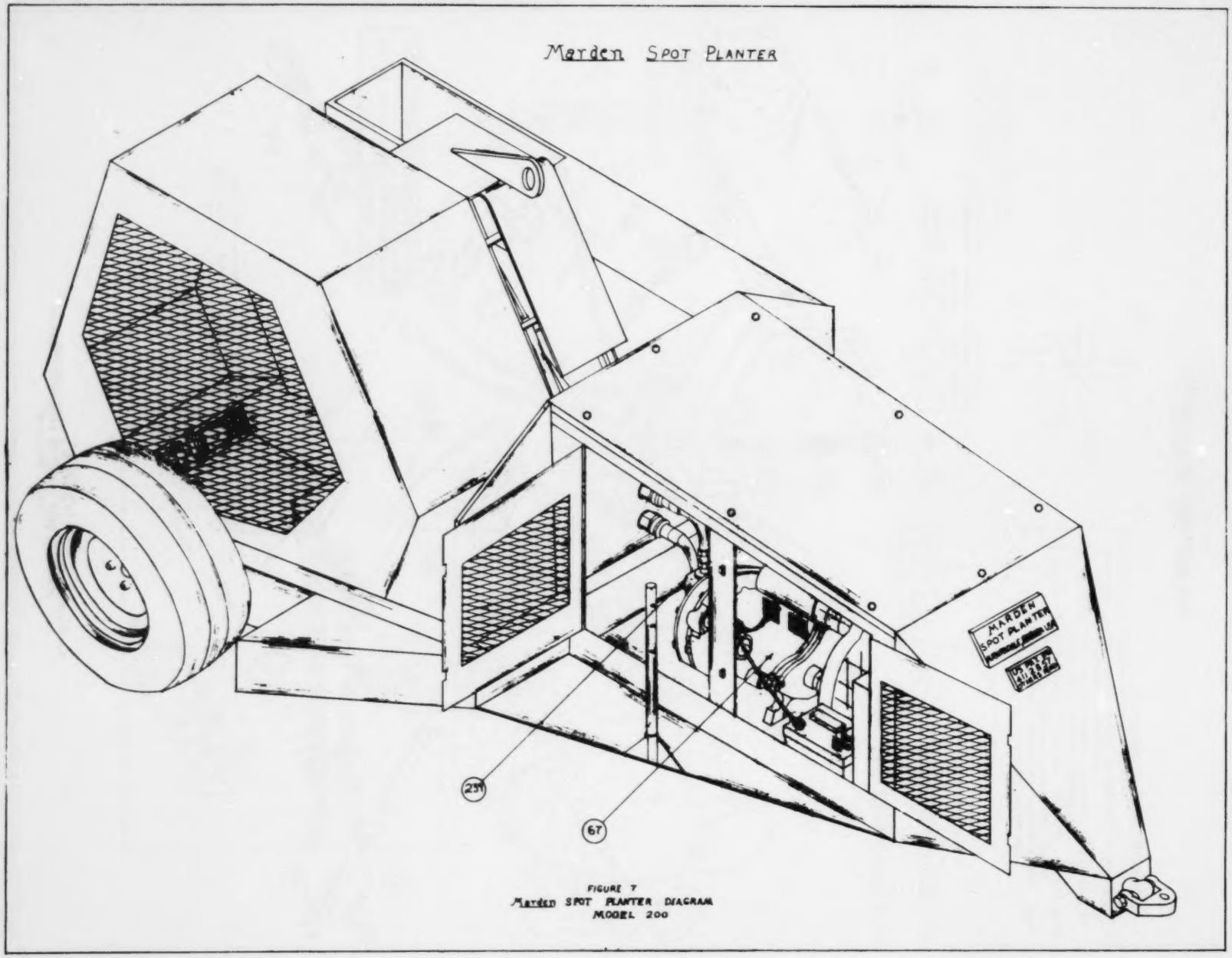


FIGURE 7
Marden SPOT PLANTER DIAGRAM
MODEL 200

Marden Spot Planter

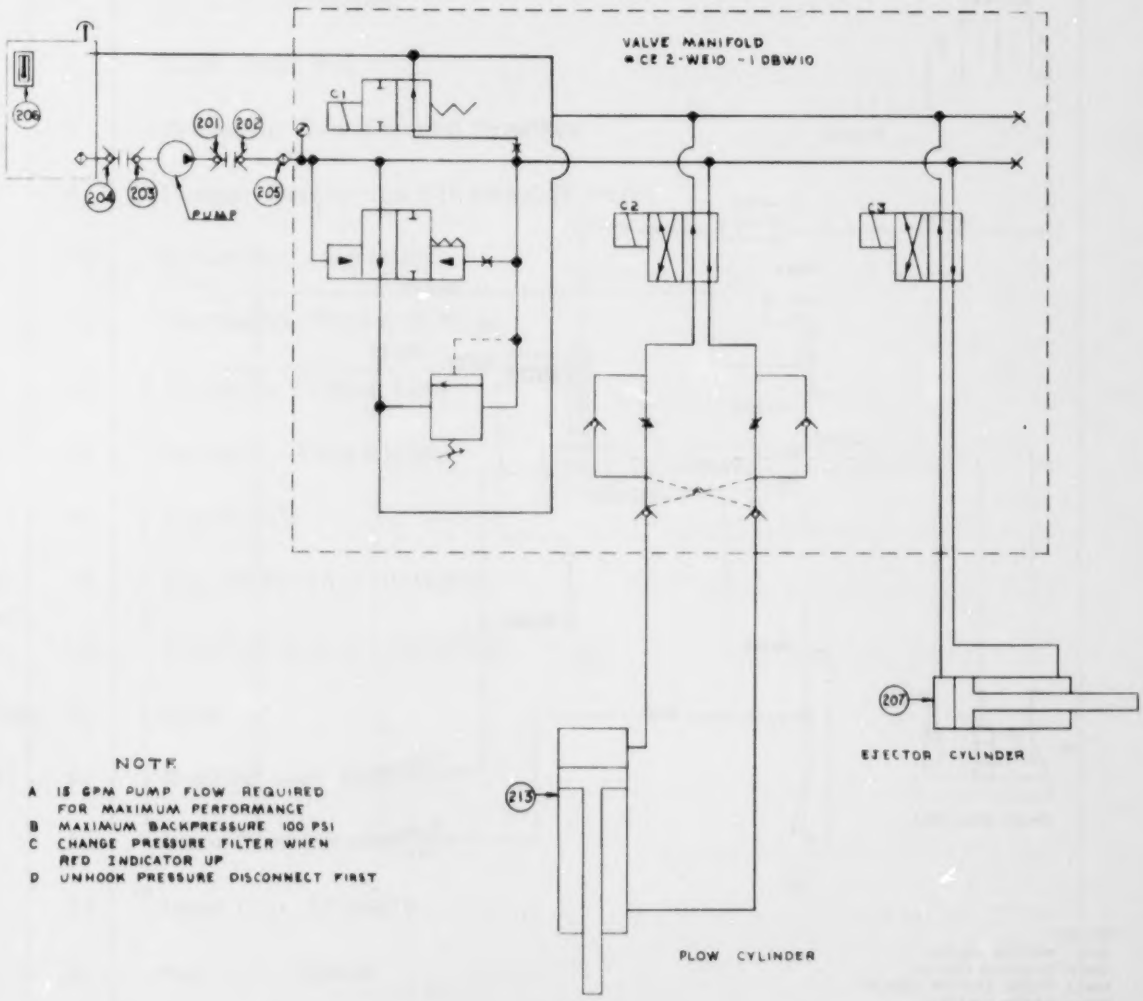
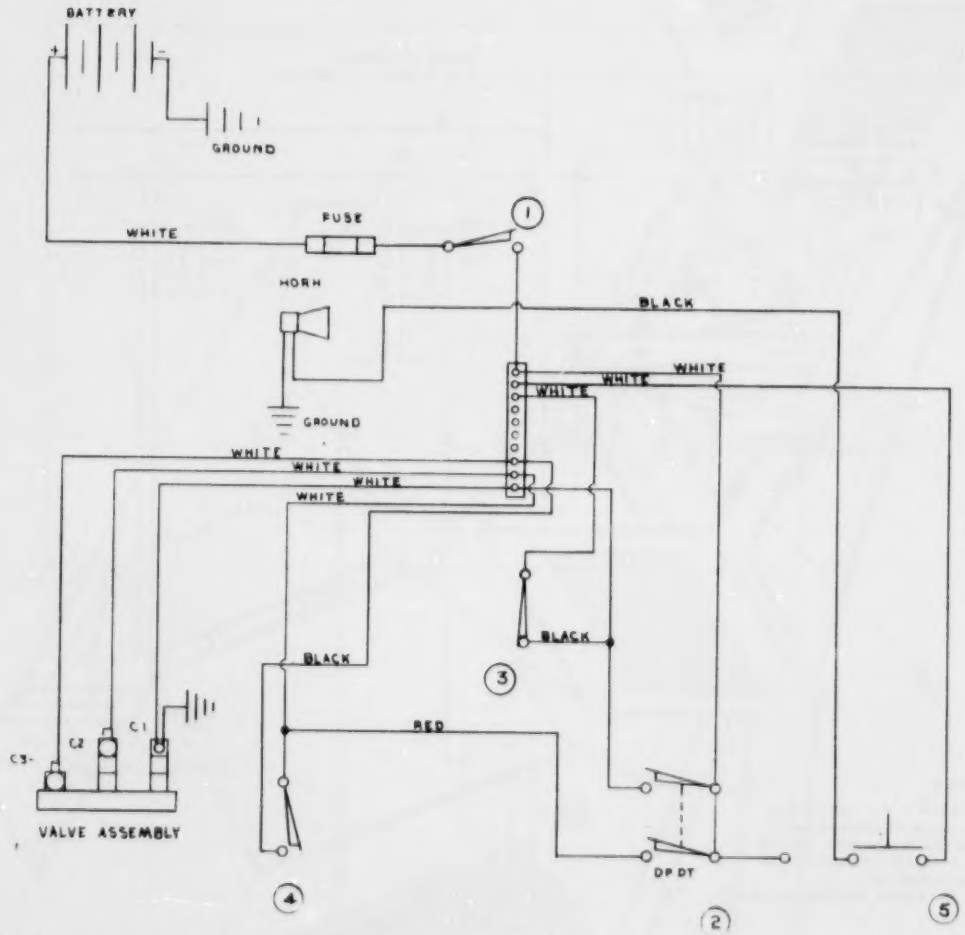


FIGURE 8
Marden SPOT PLANTER HYDRAULICS SCHEMATIC
MODEL 100 + 200

Marden Spot Planter



PART NO.
301 1 MASTER SWITCH
302 2 PLANTING SWITCH
305 3 CYCLE SHUT OFF SWITCH
304 4 DEPTH SWITCH
303 5 HORN SWITCH

FIGURE 9
Marden SPOT PLANTER ELECTRICAL DIAGRAM
MODEL 100 & 200

Marden Spot Planter

Code	Part No.	Description	No. Req.
Marden	2	Tractor clevis Pin & Key	1
"	3	Tractor clevis	1
"	5	Hitch Pivot	1
"	6	Hitch Pivot Washer	1
"	7	Hitch Pivot Nut	1
"	8	Hydraulic Tank Cap and Breather	1
"	9	Planter Frame with All Attached Parts	1
"	10	Filter Mounting Bolts	4
"	11	Turnbuckle Pins with Clips	2
"	12	Hydraulic Suction Line	1
"	13	Hydraulic Feed Nipple	1
"	14	Turnbuckle	1
EWC	15	Rim W11C-16.1 0416897	2
Good-year	16	Tire 14L x 16.1 160667216	2
Marden	17	Axle	2
EWC	18	Bearing seal 0203549	2
"	19	Inner Cone LM48548	2
"	20	Inner Cup LM48510	2
"	21	Hub Q709A	2
"	22	Outer Cup LM67010	2
"	23	Outer Cone LM67048	2

Code	Part No.	Description	No. Req.
EWC	24	Flat Axle Washer 7/8"	2
"	25	Slotted Axle Nut 7/8" SAE	2
"	26	Hub Cap 0612016	2
"	27	Cotter key 5/32 x 1½"	2
"	28	Wheel Lug Bolts 0613945	12
Marden	29	Cab Assembly only	1
"	30	Safety Belt Complete	1
"	31	Padded Comfort Seat Complete	1
"	32	Height Adjusting Bolt Complete	1
"	33	Crank Axle Mounting Bolt	4
"	34	Crank Axle Mounting Nut & Washer	4
"	35	Crank Axle Mounting Sub Plate	1
"	36	Crank Axle Pivot Bolt	1
"	37	Crank Axle Pivot Nut & Washer	1
"	38	Packing Pressure Adjusting Locknut	1
"	39	Packing Pressure Adjusting Nut	1
"	40	Packing Pressure Spring	1
"	41	Packing Pressure Spring Flat Washer	1
"	42	Packing Arm	1
"	43	Planting Arm	1
"	44	Ejector Cylinder Mounting Plate Bolt & Washer	1
"	45	Ejector Cylinder Mounting Plate	1
"	46	Ejector Cylinder Mounting Bolts & Washers	4

Code	Part No.	Description	No. Req.
Marden	47	Ejector Plate	1
"	48	Ejector Guide Fingers	2
"	49	Ejector Plate Mounting Bolt & Washer	1
EWC	50	Hub Cap 0612016	1
"	51	Slotted Axle Nut 7/8" S.A.E.	1
"	52	Flat Axle Washer 7/8"	1
"	53	Outer Cone LM67048	1
"	54	Outer Cup LM67010	1
"	55	Hub Q709A	1
"	56	Inner Cup LM48510	1
"	57	Inner Cone LM48548	1
"	58	Bearing Seal 0203549	1
Marden	59	Axle	1
"	60	Narrow Packing Wheel Complete	
"	61	Wide Packing Wheel Complete	
"	62	Bare Root Planting Blade	
"	63	Containerized Stock Planting Blade	
"	64	Blade Mounting Bolt & Washers	4
"	65	Cotterkeys 5/32" x 1½"	1
"	66	Wheel Lug Bolt	6
	67	Two Cylinder Diesel Engine Murphy/Lister	1

Code	Part No.	Description	No. Req.
Hansen	201	Female 1" Quick Disconnect 8H36	1
"	202	Male 1" Quick Disconnect w/Dust cover 8K36	1
"	203	Female 1¼" Quick Disconnect 10H41	1
"	204	Male 1½" Quick Disconnect w/Dust cover 10K41	1
Hycon	205	Pressure Filter FLY160 G10B 2/5 BYP (Replacement Element 0160D010Y)	1
"	206	Sight Level & Temp. Indicator T550-5	1
Wabco	207	Planting Ejector Cylinder MS4-HH-1.5x8-1-7/16-20 Female Seal Kit for # 207 P106860 - Rod Seal Kit P107395 - Piston Seal Kit	1
Marden	208	Ejector Pressure Line	1
"	209	Ejector Return Line	1
"	210	Filter to Valve Pressure Line	1
"	211	Plow Cylinder Return Line	1
"	212	Plow Cylinder Pressure Line	1
"	213	Plow Cylinder MP1-HH-2x24-1-3/8-3/4-16 Male Seal Kit for # 213 P106862 - Rod Seal Kit P107396 - Piston Seal Kit	1
Span	214	Span Pressure Gauge LFS-224, 0-2000	1
"	215	Valve Manifold CE2-WE10-1-DBW10	1
RexRoth	216	Relief Valve DBW20B2-10/315 UG 12 N 2/5 Seal Kit for # 216 310-001 & 310-772	1
"	217	Lock Control Z2S10-10 Seal Kit for # 217 310-209	1
"	218	Flow Control Z2FS10-2X Seal Kit for # 218 310-022	1

Code	Part No.	Description	No. Req.
RexRoth	219	3 Way Solenoid Valve Plow 4WE10C4/G12ND/5 Seal Kit for # 219 310-008	1
"	220	3 Way Solenoid Valve Ejector 4 4WE10C4/G12ND/5 Seal Kit for # 220 310-008	1
"	221	Valve To Tank Return Line	1
"	222	Relief Valve Pressure and Return Fitting	2
"	223	Solenoid Valve Pressure and Return Fitting	4
"	224	Planting Valve Bolt Kit YS10-4	1
"	225	Ejector Valve Bolt Kit BKF 1-2	1
"	226	Relief Valve Bolt Kit BK-H1-12	1
	228	Valve Manifold 202-011-008	1
	229	Manifold Adapter 002-727-000	1
Vickers	230	Relief Valve CG5-060A-C-WG-70 (12 VDC) Coil #468585 Seal Kit #920104	1
"	232	Plow Valve DG454-012A-12VDC-50 Coil # 291583 Gasket Kit # 919428	1
"	233	Counter Balance Valve CBEA-LBN-BBA	1
"	234	Ejector Valve DG454-012A-12DC-50 Coil # 291583 Gasket Kit # 919428	1
'	235	Plow Valve Bolt Kit 992-600-3-7/16	1
"	236	Ejector Valve Bolt Kit BKDG01-633	1
"	237	Relief Valve Bolt Kit BKCG06-604	1
"	238	Complete Valve Assembly # 1144	1
"	239	Hydraulic Vane Pump V20-1P8P-1C11	1

Code	Part No.	Electrics Description	No. Req.
Marden	301	Main On/Off Switch	1
"	302	Planting Switch Linemaster 532 SWN	1
NAPA	303	Horn Switch Echlin STB-6301	1
Marden	304	Horn	1
Micro	305	Cycle Shut Off Switch	1
Micro	306	Planting Depth Switch	1

All Parts Items may be purchased from Marden Manufacturing Company, Inc., or any Marden Dealer.

All Parts Items Coded other than Marden may be purchased from Marden Manufacturing Company, Inc., or any Marden Dealer or local distributor representing Original Equipment Manufacturer.

APPENDIX 2

C.F.S. V-BLADE: TECHNICAL INFORMATION

CFS V-Blade

(Also Known as TIMBERPLOW, TIMBERLAND SCARIFYING PLOW)

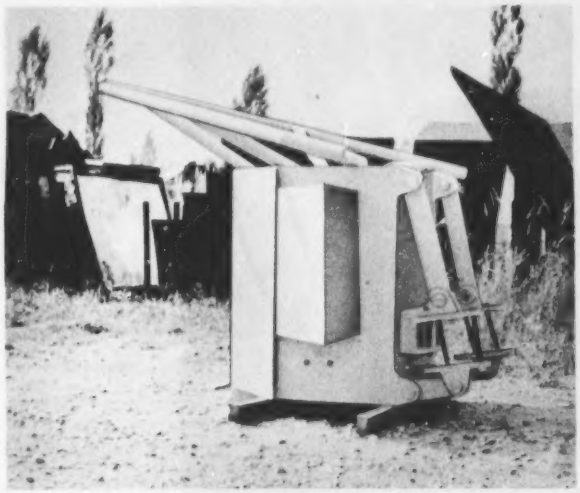


FIG. 1 CFS V-blade.
Note tubular steel bunting frame (top left) and also two attachment arms (right).
Photo courtesy of Canadian Forestry Service, Sault Ste. Marie, Ont.

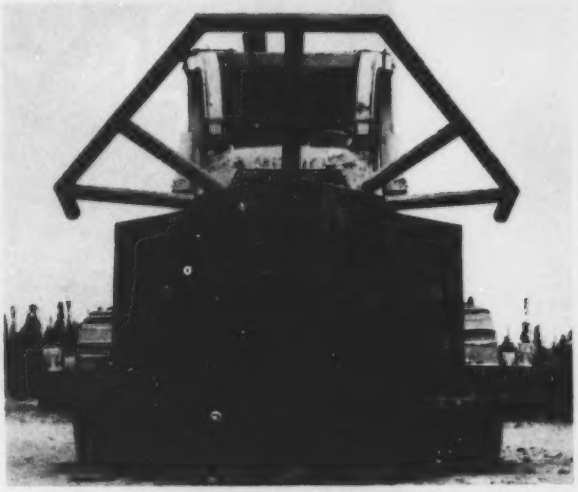


FIG. 2 Front view of CFS V-blade.
Note central V-nose (centre), two raised side wings (either side of V-nose) and stinger nose prong (bottom centre).
Photo courtesy of Canadian Forestry Service, Sault Ste. Marie, Ont.

Manufacturers and Distributors

Canadian Forestry Equipment Ltd., 170 Blvd. Industriel, St. Eustache (Montreal), Quebec. J7R 4K3. Tel (514) 472-6340 (CFS V-Blade).

Great Lakes Machine and Metal Fabricators, 225 River Road, Sault Ste. Marie, Ontario. P6A 6C3. Tel (705) 253-5101 (CFS V-Blade).

Timberland Equipment Ltd., P.O. Box 490, Woodstock, Ont. N4S 7Z2. Tel (519) 537-6262. Telex 064-74133. (Timberplow).

Price

$ 8,040.00; Timberplow (Jan. 1980).
$11,025.00; Timberplow with optional floating linkage (Aug. 1979).

Current MNR Users and No. of Units

MNR, Forest Resources Branch, Toronto has purchased two units.

TECHNICAL INFORMATION

The following information is based on the Timberplow version of the CFS V-Blade.

Approximate Overall Dimensions

Length without floating frame (cm):	241
Length with floating frame (cm):	315
Width (cm):	234
Height (cm):	203
Weight with floating frame (kg):	2,721

Working Part Particulars

Central V-Nose:	Width (cm): 70 Height (cm): 122
Adjustable Side Wings:	Extends width of central V-Nose to 172 cm. Vertically adjustable from 15-30 cm above ground level.
Bunting Frame:	Extends 66 cm in front and 51 cm above central V-Nose. Extends 30 cm to outside of side wings.
Scalping Plates:	2 plates, replaceable. Vertically adjustable at 2.5 or 7.6 cm below ground level. Clearing width: 91 cm.
Stinger Nose Prong:	Vertically adjustable from 5 to 15 cm above ground level.
Rolling Drum Coulter:	Width (cm): 60 cm Extends 13 cm below base of central V-Nose.

Additional Complementary Equipment

Optional floating frame linkage; allows plow to float vertically a total distance of 61 cm; not recommended.

PRIME MOVER

Type

Crawler tractor.

Net HP Requirement

140+

Ministry of Natural Resources
Ontario

This and other equipment item leaflets are available for a price of $1.00 each. The 4-ring bound Silvicultural Equipment Reference Catalogue containing all equipment item leaflets is available for a price of $25.00.

Copies may be obtained through:

1. *Public Service Centre, Ontario Ministry of Natural Resources, Rm. 1640, Whitney Block, Queens Park, Toronto, Ontario. M7A 1W3.*
2. *Ontario Government Publication Centre, 5th. Floor, 800 Bay St., Toronto, Ontario. M5S 1Z8.*

(1979) **J.5**

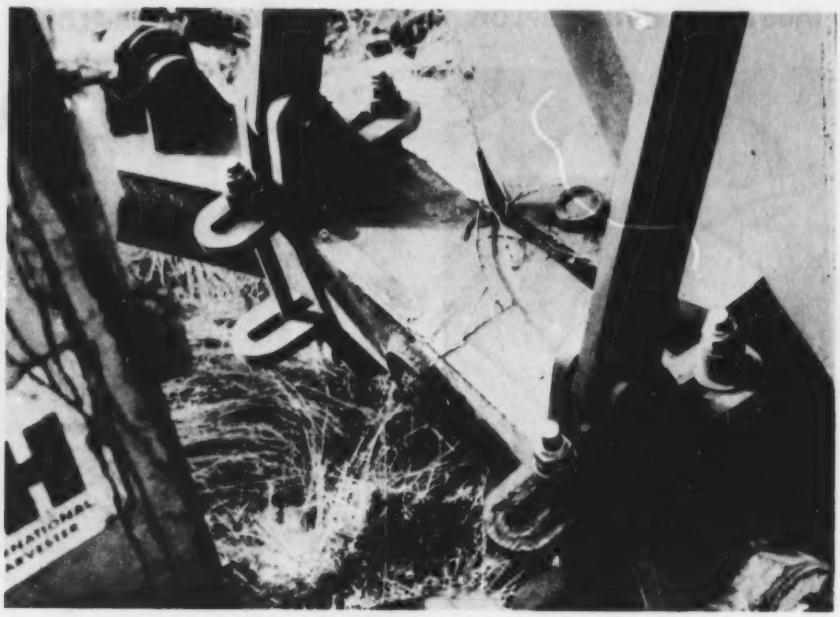


FIG. 3 Attachment of V-blade to C-frame.
Slotted clamps are bolted to C-frame on either side of centre bracket (centre).
Photo courtesy of Canadian Forestry Service, Sault Ste. Marie, Ont.

(Prime Mover Cont.'d)

Attachment
3 pt. attachment to tractor C-frame: 4 position (vertically adjustable) mounting bracket connected by pin to centre bracket of C-frame; slotted adjustable clamp bolted to C-frame on either side of centre bracket (Fig. 3). Adjustable trunion arms (Fig. 1) connect clamps either to removable floating frame or to plow. Floating frame attaches to plow using same mounting brackets as for trunion arms.

Additional Equipment
Rollover Protective Structure, fire extinguisher, hydraulic power winch, 30+ m cable.

Transport Between Sites
Plow: Hydraulic crane loader and 3 ton truck.
Plow plus prime mover: Lowbed transport float.

Additional References

(M.U. 1.4-12) Cameron, D.A. 1975. A guide to planting machine operation in the Boreal Forest of Ontario. Can. For. Serv., Sault Ste. Marie, Ont., Report 0-X-234, 23 p.

(M.U.1.4-20(B)) Cameron, D.A. 1975. Operational testing of planting machines in the Boreal Forest of Ontario. II Taylor Drum tree planter. Can. For. Serv., Sault Ste. Marie, Ont., Report 0-X-242, 31 p.

Cameron, D.A. 1978. The CFS V-blade. Can. For. Serv., Sault Ste. Marie, Ont., Report 0-278, 10 p.

Gemmel, J.R. 1975. The integration of site preparation with mechanical regeneration, p. 47-54 in Mechanization of silviculture in northern Ontario. Can. For. Serv., Sault Ste. Marie, Ont., Symp. Proc. 0-P-3.

HOW IT WORKS

FIG. 4 Blade being used in conjunction with Timberland mechanical tree planter (left). Photo courtesy of Canadian Forestry Service, Sault Ste. Marie, Ont.

General Description of Unit
Originally developed as the CFS V-blade by the Canadian Forestry Service, the Timberplow is a specialized type of V-blade consisting of a central V-nose, adjustable side wings, bunting frame, scalping plates, stinger nose prong and rolling drum coulter (Fig's 1 and 2). It is designed for attachment to a range of commonly available sizes and models of crawler tractors. It is used by itself and in conjunction with trailing equipment items such as mechanical tree planters (Fig. 4). (See Timberland Tree Planter (J.4).)

Working Principle
The V-shaped central nose and side wings push slash and other debris off to the sides. The side wings are vertically adjustable and do not extend down to ground level (Fig. 2). Material which is less than 15-30 cm in height passes under the wings. They do not scrape away soil surface layers.

The stinger nose prong extends to the front of and beneath the apex of the central V-nose. The stinger travels in the soil and lifts embedded debris such as stump roots onto the face of the V-blade where it can be deflected to the sides.

The bunting frame is used to push aside residuals.

The rolling drum coulter allows the blade to self-float reducing the tendency of the plow to skip and gouge.

The scalping plates, when attached, form a mini V-blade at the base of the central V-nose and can plow aside material down to and below ground level.

Description of Task Performed
As a slash divider, the Timberplow clears a path that is approximately 1.7 m wide. However, material that is 15-30 cm in height can pass freely beneath the side wings (i.e., the outer 50 cm on each side of the plow). The fertile soil in the upper horizons is left mostly intact. As a scalping tool, the unit plows aside material to approximately 2.5 – 7.6 cm below ground level and to a width of 1.0 m.

PRESENT USES

To site prepare for the following operation:
Planting (mechanical): bare root stock
container stock

Note: The CFS V-Blade or Timberplow is normally used in conjunction with the Timberland tree planter (Fig. 4) due to the plow's ability to continuously remove only the major debris from the path of the trailing planter and to leave the fertile soil in the upper soil horizons mostly undisturbed.

The Timberplow will be further tested in conjunction with the Timberland tree planter during 1980.

APPENDIX 3

PLANTING QUALITY ASSESSMENT:

STOCK TYPE BY SIZE

PLANTING QUALITY ASSESSMENT — Pj 2+0

SITE	ANGLE			FIRMNESS			PLANTING DEPTH			ACCEPTABLE PLANT	AVG. ROW SPACING	AVG. TREE SPACING	PROD. /PMH	SAMPLE SIZE
	Vert.	Slant (percent)	Horiz.	Firm	Loose (percent)	Unplanted	Too Deep	Good (percent)	Too Shallow	(percent)	(m)	(m)		(trees)
A	60	25	5	75	15	10	5	65	20	48	2.6	2.9	880	233
B	20	35	15	45	25	30	5	40	25	17	2.7	2.7	800	352
D	35	30	15	50	30	20	0	50	30	25	2.9	3.4	860	31
E	55	20	5	30	45	25	0	15	60	20	2.7	3.2		17

Percentages represent the relative number of the total number of trees released by the planter that fall in the corresponding categories.

Vertical + Slanted + Horizontal + Unplanted = 100%

Firm + Loose + Unplanted = 100%

Too Deep + Good + Shallow + Unplanted = 100%

PLANTING QUALITY ASSESSMENT — Sb 1+2

SITE	ANGLE			FIRMNESS			PLANTING DEPTH			ACCEPTABLE PLANT	AVG. ROW SPACING	AVG. TREE SPACING	PROD. /PMH	SAMPLE SIZE
	Vert.	Slant (percent)	Horiz.	Firm	Loose (percent)	Unplanted	Too Deep	Good (percent)	Too Shallow	(percent)	(m)	(m)		(trees)
B	40	40	15	60	35	5	0	55	40	25	3.2	3.2	750	30
C root pruned	15	15	45	45	30	25	0	35	40	10	2.7	3.4	800	24
D	25	30	25	45	35	20	0	30	50	16	2.7	3.4	675	90
D root pruned	40	25	15	55	25	20	5	50	25	25	2.9	3.4	780	30

PLANTING QUALITY ASSESSMENT — Sw 1+2

SITE	ANGLE			FIRMNESS			PLANTING DEPTH			ACCEPTABLE PLANT	AVG. ROW SPACING	AVG. TREE SPACING	PROD. /PMH	SAMPLE SIZE
	Vert.	Slant (percent)	Horiz.	Firm	Loose (percent)	Unplanted	Too Deep	Good (percent)	Too Shallow	(percent)	(m)	(m)		(trees)
A	30	45	10	65	20	15	5	55	25	25	2.4	3.2	670	67
D	55	25	10	55	35	10	10	40	40	35	2.9	3.4		42
E	0	5	0	5	0	95	0	5	0	0	2.1	3.4		17

PLANTING QUALITY ASSESSMENT — Sw 2+2

SITE	ANGLE			FIRMNESS			PLANTING DEPTH			ACCEPTABLE PLANT	AVG. ROW SPACING	AVG. TREE SPACING	PROD. /PMH	SAMPLE SIZE
	Vert.	Slant (percent)	Horiz.	Firm	Loose (percent)	Unplanted	Too Deep	Good (percent)	Too Shallow	(percent)	(m)	(m)		(trees)
A	25	50	10	65	20	15	5	65	15	25	2.4	4.6	600	29
C	25	40	10	50	25	25	0	30	45	10	2.7	2.6	750	20
C root pruned	0	35	35	30	40	30	0	20	50	0	2.6	4.4	745	14

APPENDIX 4

TOTAL TRIAL COST

The total cost for the trial is a sum of the following cost components:

A)	Salaries		
	i) Pre-trial site analysis, data compilation, and equipment preparation; one RT2 student (56 hours regular time, 1.5 hours overtime); one Forester in Training (57.5 hours — not charged to trial)		$ 564.20
	ii) Tree pickup Thunder Bay, one RT2 student (8 hours regular time, 1.5 hours overtime)		$ 98.80
	iii) Planting trials, two RT2 students (144 hours regular time, 102 hours overtime); one RT2 casual (64 hours regular time, 51 hours overtime); one Forester in Training (122 hours — not charged to trial)		$ 4 363.82
		Total	$ 5 026.82
B)	Transportation and Communication		
	i) Bush lunches		$ 57.00
	ii) Freight charges to obtain Marden and V-blade and return Marden to Toronto		$ 4 256.90
		Total	$ 4 313.90
C)	Services		
	i) Manual labour		$ 126.00
	ii) Prime Mover rental		$ 8 187.50
	iii) Float rental		$ 1 139.00
	iv) Loading and unloading planter		$ 95.00
	v) Access expenditure		$ 63.90
	vi) Welding		$ 106.96
	vii) Video-camera rental		$ 199.64
		Total	$ 9 918.00
D)	Supplies		
	i) Diesel fuel		$ 87.54
	ii) Bolts		$ 16.52
	iii) Miscellaneous		$ 121.33
		Total	$ 225.39
E)	Grand Total		$19 484.11

The total expenditure of $19 484.11 does not include the cost of approximately 40 hours of time required to analyse, compile, and write this report.

APPENDIX 5

MARDEN SPOT PLANTER VENDOR SERVICE

Marden Spot Planter Vendor Service

Planter Parts:

Canadian Forestry Equipment
2567 Drew Road
Mississauga, Ontario
L4T 1G1
(416) 678-1586

Marden Manufacturing Co. Inc.
P.O. Box 1157
Auburndale, Florida 33823

(813) 967-1111

Diesel Engine:

Authorized Murphy Diesel Dealership
Northwestern Ontario — Blackwood Hodge
399 Memorial Ave.
Thunder Bay, Ontario
P7B 3Y4
(807) 344-6674

Current publications of the Ontario Ministry of Natural Resources and price lists are obtainable through the Ministry of Natural Resources Public Service Centre, Room 1640, Whitney Block, 99 Wellesley St. West, Toronto, Ontario M7A 1W3 (personal shopping and mail orders).

And:

Personal shopping: Ontario Government Bookstore, Main Floor, 880 Bay St., Toronto.

Mail orders: MGS Publications Services Section, 5th floor, 880 Bay St., Toronto, Ontario M7A 1N8. Telephone 965-6015. Toll-free long-distance 1-800-268-7450; in Area Code 807, dial 0-Zenith 67200.

Cheques or money orders should be made payable to the Treasurer of Ontario, and payment must accompany order.